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UPPER DEVONIAN SEDIMENTS OF THE CANN, COMBIENBAR AND BEMM RIVERS AREA, EASTERN VICTORIA

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Abstract

Three areas of Upper Devonian sediments outcropping in the valleys of the Upper Cann, Combienbar and Bemm Rivers of Eastern Victoria, have recently been mapped in some detail. The sediments are preserved in small troughs downfaulted into the Lower Palaeozoic basement rocks and consist of sandstones, conglomerates, red sandstones and red siltstones with the 'red bed'—type sediment predominating in the upper part of the succession. Certain horizons contain poorly preserved plant fossils and fragmental fish remains, but most of the succession is unfossiliferous. The sandstones within the sequence are quartzose and lithic sandstones with the latter containing rock fragments of mainly local provenance.

Introduction

Reconnaissance mapping in Eastern Victoria during recent years has yielded information on the distribution and nature of Upper Devonian sediments outcropping in the valleys of the Upper Cann, Combienbar and Bemm Rivers. Prior to the publication of the 1:1,000,000 geological map of Victoria by the Mines Department in 1963, only two areas of these rocks were shown on maps, one in the Bemm River valley and the other in the Upper Cann River valley. The recent mapping established that three discrete areas of outcrop occur in small inliers downfaulted into the Lower Palaeozoic basement rocks. (Fig. 1a.)

The Upper Devonian rocks outcrop mainly in negative relief areas and contrast with other areas of Upper Devonian-Lower Carboniferous rocks in Gippsland where the massive outcrops constitute rugged highland country e.g. the Avon River Group of Northern Gippsland and the Genoa River Beds of eastern Victoria. The absence of large thicknesses of massive and resistant quartzose sandstones from the Upper Cann, Combienbar and Bemm River successions is one factor contributing to the lack of dominant land forms.

The rivers, particularly the Cann and Combienbar, have eroded their courses along the axes of the fault troughs in which the comparatively soft Upper Devonian sediments have been preserved, and the Bemm River southwest of Club Terrace has carved a valley into the softer 'red bed'-type sediments of the succession.

Previous published work on this district is confined to brief references to alluvial and reef gold mining (Whitelaw 1898, Stirling 1898, Murray 1898) and notes on the physiography of the County of Croajingolong by Stirling (1889). Stirling recorded sandstones and conglomerates of probable Devonian age on the divide between the Cann and Bemm Rivers and steeply dipping quartzose sandstones and red sandstones at Buldah in the Upper Cann River valley. Whitelaw (1898) noted Devonian sandstone, shale and conglomerates unconformably overlying slates in a tributary of the Cann River northeast of Buldah. In more recent times Thomas (1949) referred to reddish shales and sandstones in cuttings on the Princes Highway near the Bemm River bridge.

A thin residual of weathered basalt caps a spur bearing northwest from the junction of the Goolengook and Bemm Rivers. This outcrop was mentioned by Whitelaw (p. 65) with reference to alluvial mining in the Bemm River valley. Underlying the basalt there is a thin deposit of sand and gravel containing boulders and cobbles of reef quartz, slate, granite and metamorphic rocks (Whitelaw *op. cit.*). The rock is an olivine labradorite basalt consisting of phenocrysts of olivine and labradorite set in a groundmass of labradorite laths, granular augite, iron ore mineral and yellow brown coloured glass. The basalt probably belongs to the Older Volcanic Suite of Lower Tertiary age.

Quartz gravels are found capping spurs in the southern part of the Bemm River area between the tributary streams Goolengook River, Crab Hole Creek and Boulder Creek. These gravels occur at approximately the same level as those underlying the basalt lava. Other gravel deposits are found down in the Bemm River valley on the lower slopes southwest of Club Terrace.

The Upper Devonian sequence has been tentatively divided into three units. Units 1 and 3 are distinguished by the relative abundance of 'red bed'-type sediments and Unit 2 is recognized only in the Combienbar succession. The units will be described in more detail later in the text. The boundaries between the units as shown in Figs. 1b and 2 are not sharply defined in the field.

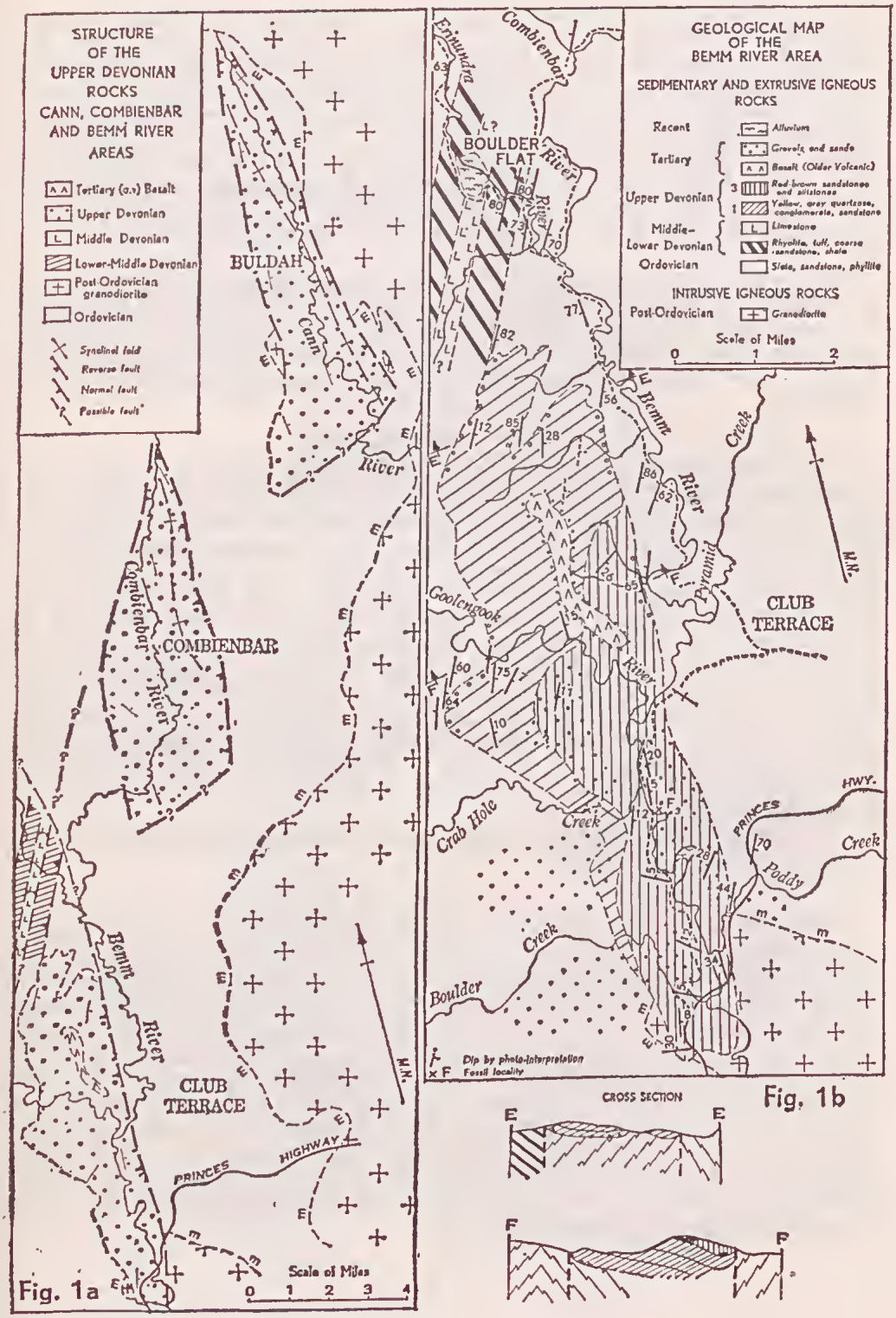
The sedimentary rocks rest unconformably on tightly folded Lower Palaeozoic sedimentary rocks and intrusive granitic rocks. In road cuttings on the Princes Highway near the Bemm River bridge, an unconformable contact is exposed between red sandstones, siltstones and weathered granodiorite. This contact between sediments, which are believed to be high in the Bemm River sequence, and the granodiorite, suggests that the pre-Upper Devonian surface was quite irregular. Lenticular bedding however could complicate the stratigraphic interpretation.

The basement rocks

The basement rocks include slates, sandstones, mudstones, phyllites, mica schists and hornfels, which are lithologically comparable with the rocks forming highland country in the County of Croajingolong. These rocks are tightly folded and cleaved, varying in strike from WNW to ENE. No fossils were found in these rocks during the recent mapping but lithologically they are comparable with rocks in which Carne (1897) and Thomas (1949) found graptolites of Upper Ordovician age.

East and south of the areas of Upper Devonian outcrop, the basement sedimentary rocks are intruded by the granitic rocks which are continuous with the Bega Granite complex of southeast New South Wales. Hall (1959, 1960) has described the Bega Granite as a composite intrusion varying in composition from a muscovite granite to a hornblende biotite granite. Samples collected from Victoria vary from pinkish grey to dark grey in colour and are fine to coarse grained. In thin section the rock has the composition of a hornblende granodiorite. The granodiorite is usually massive, but strong foliation can be observed in some areas. The metamorphic aureole along the western edge of the mass is narrow, considering the size of the granitic mass, and where exposed in a gorge in the Cann River valley downstream from the Lock Up Creek junction, the contact is steeply dipping to the west.

At Boulder Flat (Fig. 1b) on the Errinundra River approximately 1½ miles upstream from the junction with the Combienbar River, a narrow belt of Lower Middle Devonian rocks outcrop. The rocks, consisting of acid lavas interbedded with tuffs, agglomerates, coarse sandstones, mudstones, fossiliferous shales and limestones, which are strongly sheared and metamorphosed (Talent 1965), have been downfaulted into the basement rocks. Thomas (1949) mapped a section


STRUCTURE OF THE UPPER DEVONIAN ROCKS CANN, COMBIENBAR AND BEMM RIVER AREAS
Tertiary (a.v) Basalt
Upper Devonian
Middle Devonian
Lower-Middle Devonian
Post-Ordovician granodiorite
Ordovician
Synclinal fold
Reverse fault
Normal fault
Possible fault
BULDAH
Cann River
COMBIENBAR
Combienbar River
Bemm River
CLUB TERRACE
PRINCES HIGHWAY
M.N.
Scale of Miles
0 1 2 3 4
Fig. 1a
GEOLOGICAL MAP OF THE BEMM RIVER AREA
SEDIMENTARY AND EXTRUSIVE IGNEOUS ROCKS
Recent
Alluvium
Tertiary
Gravels and sands
Basalt (Older Volcanic)
Upper Devonian
Red-brown sandstones and siltstones
Yellow, grey quartzose, conglomeratic, sandstone
Middle-Lower Devonian
Limestone
Rhyolite, tuff, coarse sandstone, shale
Ordovician
Slate, sandstone, phyllite
INTRUSIVE IGNEOUS ROCKS
Post-Ordovician
Granodiorite
Scale of Miles
0 1 2
Combienbar
Errinundra
BOULDER FLAT
Bemm River
Goolengook River
Bryants Creek
CLUB TERRACE
Crab Hole Creek
Poddy Creek
Boulder Creek
PRINCES HWY.
M.N.
Dip by photo-interpretation
Fossil locality
CROSS SECTION
E E
F F
Fig. 1b

along the Errinundra road and noted a high angle strike fault along the eastern edge between Upper Ordovician slates and tuffaceous sediments. The belt is only 1¼ miles wide with the limestone outcropping along the middle of the structure and lavas and sediments to the east and west. Teichert (1946) recorded fossils of Middle Devonian age from the limestone and suggested that the formation was equivalent to the Buchan Limestone, and Bain (1949) examined the associated rhyolite lavas and tuffs and described them as equivalents of the Snowy River Volcanics. Along the New South Wales coast near Eden, volcanics of similar composition outcrop and Hall (1949) has suggested that these rocks which underlie Upper Devonian sediments and volcanics could be Lower to Middle Devonian in age.

The belt of rocks at Boulder Flat has been mapped as far south as the northwest edge of the Upper Devonian outcrops, and north of the Errinundra River, but does not outcrop on the spur between Bungywaar Creek and the Errinundra River valley. It is possible that the structure has been truncated by faulting as depicted in Fig. 1a, but more detailed mapping will be necessary to establish the true relationship.

The Upper Devonian rocks

These rocks consist of relatively soft, gently dipping sediments varying from cobble conglomerates to siltstones and mudstones. Rock types include yellow to grey quartzose sandstones, polymict and oligomict conglomerates, pebbly quartzose sandstones, greenish to brownish grey medium grained sandstones and purplish to red sandstones, siltstones and mudstones. The strata is predominantly easterly-dipping except near the eastern marginal faults where drag has produced steep westerly dips and overturning. The easterly dip results in the oldest sediments of the sequence outcropping along the western edge of the fault troughs. This interpretation is used in the cross-sections A-F (Figs. 1b & 2). An assumption made in the drawing of these sections is that the beds are not lenticular. Because of the absence of good continuous outcrop the lateral development of individual beds could not be studied, but in the example of Unit 2 in the Combienbar area this group of beds appeared to be persistent in lateral extent. A total thickness of between 2,000 and 3,000 feet of sediment may be present if the beds are continuous as shown in the cross-sections.

A tentative subdivision of the formation into three units has been proposed until a better correlation can be made.

Unit 1

This unit forms the lower beds of the succession in each area and includes mainly yellow brown to grey quartzose sandstones, yellow to red pebbly sandstones and conglomerates with subordinate grey, red, yellow medium grained sandstones and siltstones. Conglomerates and pebbly sandstones are consistently found along the western edge of the three areas, but they are also found higher in the sequence. These conglomerates are probably lenticular within quartzose sandstone groups of beds and cross-bedding is a common feature. The conglomerates near the western edge of the fault troughs are polymict with well rounded reef quartz pebbles and cobbles, and sub-rounded to angular pebbles and cobbles of quartzite, sandstone and slate make up the other rock types. Granitic rocks were not observed as pebbles or cobbles, even though a large tract of the country east of the area is composed of granitic rocks. In the oligomict conglomerates and pebbly sandstones the rock types are usually reef quartz and quartzite.

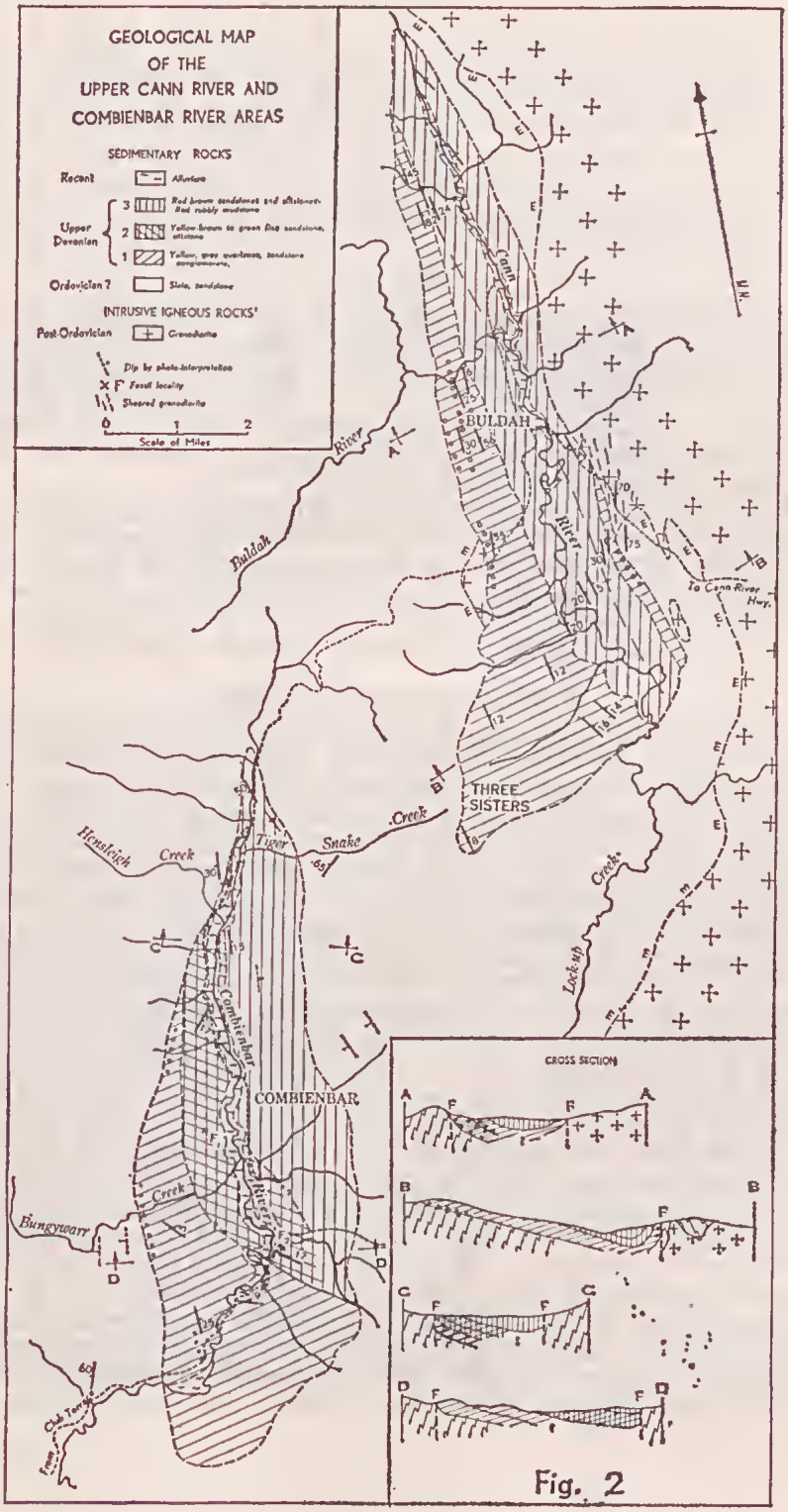

GEOLOGICAL MAP
OF THE
UPPER CANN RIVER AND
COMBIENBAR RIVER AREAS
SEDIMENTARY ROCKS
Recent
Alluvium
Upper Devonian
3
2
1
Red-brown sandstones and siltstones. Red rubbly mudstone
Yellow-brown to green fine sandstone, siltstone
Yellow, grey quartzose sandstone conglomerate
Ordovician ?
Slate, sandstone
INTRUSIVE IGNEOUS ROCKS
Post-Ordovician
Granodiorite
Dip by photo-interpretation
Fossil locality
Sheared granodiorite
0 1 2
Scale of Miles
BULDAH
THREE SISTERS
COMBIENBAR
Cann River
Buldak River
Tiger Snake Creek
Hosaleigh Creek
Combienbar River
Bungywarry Creek
Lock-up Creek
To Cann River Hwy.
CROSS SECTION
A F F A
B F B
C F F C
D F F D

Fig. 2

Unit 2

This unit occurs only within the Combienbar succession and consists of approximately 500 ft of green to brown medium grained micaceous sandstones with some red sandstones and siltstones. The sediments are slabby to well bedded with some laminated strata. The lighter coloured beds contain fragmental fossil plant material and two collections were made from localities F1 and F2 (see Fig. 2). At locality F1 a large stem cast was found and several samples contained small indeterminate fish plates. If large enough excavations are made at locality F1, some worthwhile specimens may be obtained.

Unit 3

This part of the succession consists mainly of red bed-type sediments, purplish red to brownish red medium grained sandstones, siltstones and 'rubbly red' mudstones with characteristic spherical and crumbly mode of weathering and lack of obvious bedding. Occasional pebble beds occur in this unit as well as laminated pink, grey, yellow and green fine grained sandstones and siltstones. Some of the thin red and green siltstone beds (locality F3) contain fragmental plant fossil remains, but most of the material is indeterminate.

The Upper Cann, Combienbar and Bemm Rivers have eroded relatively wide valleys in the sediments of this unit. Where the streams have carved into the Lower Palaeozoic rocks, the valleys tend to be narrow and steep-sided. Alluvial flats have been formed by the Upper Cann and Combienbar Rivers where they flow through the red beds. These alluvial flats were heavily timbered in their virgin state (Stirling 1889, p. 86) although the foothills were sparsely timbered and well grassed.

Age evidence and correlation

The stratigraphic evidence suggests that these sediments are younger than the Bega Granite (epi-Middle Devonian according to Hall (1959)) and the Lower-Middle Devonian volcanic and sedimentary rocks which they partly overlie south of Boulder Flat. Lithologically the sediments resemble rocks between Platte and Bombala in New South Wales described by McRoberts (1948) and the Genoa River Beds in the Upper Genoa River valley. Carne (1897) collected plant fossils from the Genoa River Beds and Dun (1897) described them as typical of the Upper Devonian. Hall (1959) suggested that the Genoa River Beds are the non-marine lateral equivalents of the Merrimbula Formation of the Eden-Pambula district of south-east New South Wales, because of the presence of similar plant fossils in the two formations. The Merrimbula Formation consists of conglomerates, arkose, shale, purple brown sandstones and quartzite, and marine fossils and plant fossils have been found in the formation (Brown 1931). Faunas from marine beds within the Merrimbula Formation collected in the vicinity of Eden by J. Steiner of the Australian National University include *Cyrtospirifer australis* and *Cyphotopterorhynchus* inter alia, on the one hand re-emphasizing the 'Lambian' affinities of the fauna and its Upper Devonian age, and indicating that the fauna is most probably late Frasnian (J. A. Talent, pers. comm.). The Merrimbula Formation conformably overlies and overlaps the Lochiel Formation, which consists of interbedded conglomerates, sandstones, shales and volcanic rocks (Hall 1959). The Upper Cann, Combienbar and Bemm River sequences do not include any volcanic rocks, although detrital fragments of possible igneous origin are found in the sandstones. These are not regarded on present evidence as being marine in origin, but there is no evidence against them being regarded as a lateral equivalent of the Merrimbula Formation, a correlation which Hall has suggested for the Genoa River Beds.

J. G. Douglas of the Geological Survey of Victoria kindly examined plant fossils collected from locality F1. He noted that most of the specimens contained plant debris, small branches and fern-like foliage, but one large stem cast of the Order Lepidodendrales was found in the collection. From the rather poor material, Mr Douglas deduced that the sediments were not older than Upper Devonian.

Composition of the sandstones

The sediments included in these Upper Devonian successions vary in grain size from cobble conglomerates to red mudstones. To obtain some information relevant to the source rock of the sediments, thin sections were made of specimens of sandstone from different localities. Micrometric analyses were made and the results plotted as a QFR diagram (Fig. 3), where Q is detrital quartz content, F—Felspar and R—rock fragments, calculated on a matrix free basis. The composition varies from quartzose sandstone to lithic sandstone independent of the unit from which the samples were collected.

Average micrometric analyses

Unit	No. of Samples	Quartz	Felspar	Rock Frags.	Mica	Iron oxide	Matrix
1	6	65·6	2·8	19·0	0·2	0·7	11·6
2	2	64·4	1·4	12·8	0·9	0·3	20·1
3	14	60·8	1·5	16·0	0·8	1·8	19·1

The rock types represented as detrital fragments are predominantly of local provenance except for rare dyke or lava rocks with trachytic texture. Common lithologies were Lower Palaeozoic sandstone, quartzite, reef quartz, slate, black slate, mica schist, quartz schist and contemporaneous sediments such as red siltstone and mudstone. Most of these rock types outcrop in the immediate area. Although a considerable proportion of the country east of the areas consists of granitic rocks which are pre-Upper Devonian, it is significant that felspar is not an important constituent in the sandstone composition. Specimens from the Upper Cann River area contained up to 7·9 per cent, but others from the southern part of the Bemm River area where the sediments unconformably overlie decomposed granodiorite, did not contain a high percentage of felspar.

The absence of granitic rock types from the conglomerates and the low felspar content of the sandstones contrasts markedly with the Genoa River Beds which have a basal arkosic conglomerate (Hall 1959). Similarly both the Merrimbula Formation and the Lochiel Formation along the south-east coast of N.S.W. contain arkose and arkosic conglomerates. The comparatively high percentage of basement rock fragments, mainly Upper Ordovician sediments and metamorphics, within the lithic sandstones of the successions may suggest that the source area for the sediments was to the west, where with the exception of the Mt Ellery granodiorite the rocks are of sedimentary or metamorphic type.

Structure

The small inliers of comparatively soft Upper Devonian sediments undoubtedly owe their preservation to down-faulting into the basement rocks. The sediments probably were originally part of more extensive deposits passing laterally into marine equivalents to the east.

The strata are generally easterly dipping with strike direction varying from north-west to north-east in the Combienbar and Bemm River areas (Figs. 1b and 2). Near the trough margins the strike directions are influenced by the drag effects of the boundary fault. Drag along the eastern boundary faults has resulted in steep westerly-dipping and overturned strata. The resulting structure within fault troughs is an asymmetrical syncline as shown in the cross-sections A to F (Figs. 1b and 2). Along the western edge of the structures faulting has also steepened easterly dips and produced overturning. The overturning of the beds can be observed where roads cut across the structure, as for example on the Buldah Gap road (Fig. 2). At this locality the intensity of the faulting and shearing on the eastern edge of the Upper Cann River section is indicated by a wide zone of mylonised granodiorite. The degree of overturning produced by the boundary faults, particularly in the Upper Cann and Combienbar areas, suggests that the faults may be high angle reverse faults in part. In both these areas the faults converge to the north, pinching-out the Upper Devonian sediments. In the upper part of the Cann River section near the headwaters of the stream, the only Upper Devonian sediments visible are

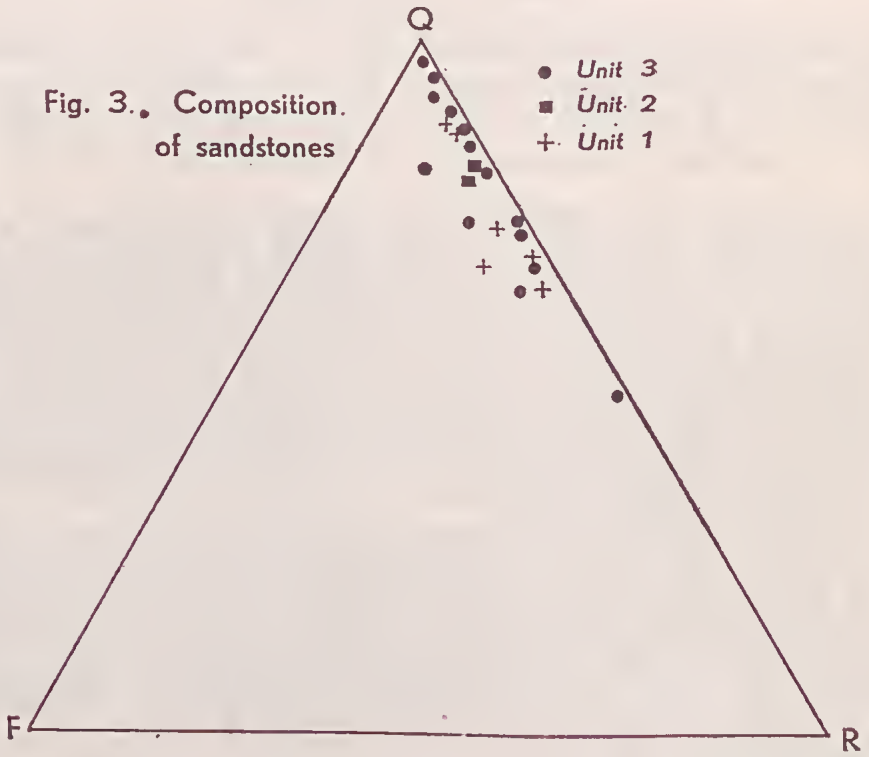


Fig. 3. Composition of sandstones

in the bed of the stream while the sides of the narrow valley are composed of Ordovician rocks. The faulted contacts are blanketed by scree deposits. The influence of the boundary fault along the western edge of the Upper Cann structure appears to decrease to the south or perhaps changes in direction. In the vicinity of the Three Sisters, which consist of questa-type peaks of coarse pebbly sandstone, the contact

appears to be an unconformable rather than a faulted relationship (Fig. 2). In the Bemm River area the eastern boundary fault is exposed in tributary streams of the Bemm River west of Club Terrace. The extrapolation of this fault to the north-west to terminate the narrow belt of Lower-Middle Devonian rocks north of Boulder Flat (Fig. 1a) is conjectural. The structural relationship between the Upper Devonian rocks and the basement rocks along the western edge of the Bemm River succession is not clear. In the bed of the Goolengook River the Ordovician rocks are in faulted contact with steep easterly-dipping Upper Devonian pebbly sandstones, but on the spur to the south between the Goolengook River valley and the Crab Hole Creek valley, the contact appears to be a gentle easterly-dipping unconformity. Outcrops on the new alignment of the Princes Highway suggest an unconformable rather than a faulted contact on the western margin. However an irregular pre-Upper Devonian surface and steep topography possibly complicate the picture.

The prevailing easterly dips of the Upper Devonian rocks could indicate that the narrow belt of Lower to Middle Devonian rocks at Boulder Flat is part of a major structure which has controlled the western limits of the Upper Devonian outcrops. The three small structural troughs are arranged 'en echelon', appearing as lozenge-shaped areas which may be the expression of a regional shear pattern; however shear zones in the basement rocks would have to be mapped and studied in detail to obtain an idea of a regional structure pattern.

Acknowledgements

The author is grateful to Dr D. E. Thomas, Director of Geological Survey, for permission to submit this paper for publication, and to Mr R. G. Williams for his help and companionship in the field. Mr J. G. Douglas kindly examined the fossil plants, and Dr J. A. Talent supplied the information on the recent determination of fossils from the Merrimbula Formation.

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